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Digital Video Service Multiplex and Transport System Standard for Cable Television

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DIGITAL VIDEO SERVICE MULTIPLEX AND TRANSPORT SUBSYSTEM STANDARD FOR CABLE TELEVISION

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1. SCOPE

This document describes the transport subsystem characteristics and normative specifications of the in-band Service Multiplex and Transport Subsystem Standard for Cable Television.[1]

2. NORMATIVE REFERENCES

The following documents contain provisions which in whole or in part, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and amendment, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

1. ANSI/SCTE 07 2000 (formerly DVS 031), Digital Video Transmission Standard for Cable Television.
2. ATSC A/52A (2001), Digital Audio Compression (AC-3).
3. ATSC A/53B (2001), ATSC Digital Television Standard.
4. ATSC A/65A (2000), Program and System Information Protocol (PSIP) for Terrestrial Broadcast and Cable.
5. ATSC A/90 Data Broadcast Standard (2000).
6. EIA-708-B, Digital Television (DTV) Closed Captioning (1999)
7. EIA/CEA-766-A (2000), U.S. and Canadian Rating Region Tables (RRT) and Content Advisory Descriptors for Transport of Content Advisory Information Using ATSC A/65A Program and System Information Protocol (PSIP).
8. ISO/IEC IS 13818-1, (2000), "Information Technology—Generic coding of moving pictures and associated audio—Part1: Systems."
9. ISO/IEC IS 13818-2, (2000), "Information Technology—Generic coding of moving pictures and associated audio—Part 2: Video."
10. ISO/IEC 13818-6, (1998), "Information Technology—Generic coding of moving pictures and associated audio—Part 6: Digital Storage Media Command & Control," Chapter 2, 4-7, 9, 11.
11. SCTE 18 2001 (formerly DVS 208), Emergency Alert Message for Cable.

[1] Informative note: This standard applies only to Transport Streams transmitted on cable using 64- or 256-QAM modulation in accordance with ANSI/SCTE 07 2000 *Digital Video Transmission Standard for Cable Television*.

12. ANSI/SCTE 19 2001 (formerly DVS 132), Standard Methods for Isochronous Data Services Transport.
13. SCTE 27 1996 (formerly DVS 026), SCTE Method – Subtitling Methods for Broadcast Cable.
14. ANSI/SCTE 53 2002 (formerly DVS 051), Methods for Asynchronous Data Services Transport.
15. ANSI/SCTE 42 2002 (formerly DVS 311) IP Multicast for Digital MPEG Networks.

3. DEFINITIONS

3.1 Compliance notation

As used in this document, "*shall*" denotes a mandatory provision of the standard. "*Should*" denotes a provision that is recommended but not mandatory. "*May*" denotes a feature whose presence does not preclude compliance that may or may not be present at the option of the implementer.

3.2 Acronyms and Abbreviations

The following acronyms and abbreviations are used within this specification:

ASTD Ancillary Service Target Decoder
ATSC Advanced Television Systems Committee
CA Conditional Access
CAT Conditional Access Table
CRC Cyclic Redundancy Check
CVCT Cable Virtual Channel Table
DET Data Event Table
DOCSIS Data Over Cable Service Interface Specification[2]
DSM-CC Digital Storage Media Command and Control
DST Data Service Table
DTS Decoding Time Stamp
DVB Digital Video Broadcasting
DVS Digital Video Subcommittee
EA Emergency Alert
ECM Entitlement Control Message
EIT Event Information Table
ES Elementary Stream
ETT Extended Text Table
IEC International Electrotechnical Commission
ISO International Organization for Standardization

[2] See http://www.cablemodem.com/ or ANSI/SCTE 22-1 2002.

MGT Master Guide Table
MPEG Moving Picture Experts Group
MRD MPEG-2 Registration Descriptor
PAT Program Association Table
PES Packetized Elementary Stream
PID Packet Identifier
PMT Program Map Table
PSI Program Specific Information
PSIP Program and System Information Protocol
PTS Presentation Time Stamp
QAM Quadrature Amplitude Modulation
RRT Rating Region Table
SI Service Information
STT System Time Table
TS Transport Stream
T-STD Transport Stream System Target Decoder
TVCT Terrestrial Virtual Channel Table
VBV Video Buffering Verifier

4. SYSTEM OVERVIEW

The transport format and protocol for the Service Multiplex and Transport Subsystem Standard for Cable Television is a compatible subset of the MPEG-2 Systems specification defined in ISO/IEC 13818-1. It is based on a fixed-length packet Transport Stream approach which has been defined and optimized for digital television delivery applications.

As illustrated in Figure 4.1, the transport function resides between the application (e.g., audio or video) encoding and decoding functions and the transmission subsystem. The encoder's transport subsystem is responsible for formatting the coded elementary streams and multiplexing the different components of the program for transmission. The receiver is responsible for recovering the elementary streams for the individual application decoders and for the corresponding error signaling. The transport subsystem also incorporates other higher protocol layer functionality related to synchronization of the receiver.

One approach to system multiplexing approach may be to consider it a combination of multiplexing at two different layers. In the first layer, single program Transport Streams are formed by multiplexing Transport Stream (TS) packets from one or more Packetized Elementary Stream (PES) and/or private section (ISO/IEC 13818-1 [8] Table 2-30) sources. In the second layer, a single program Transport Stream forms (or two or more may be are combined to form) a service multiplex (also known as a multi-program Transport Stream in the MPEG-2 Systems standard, and a digital television standard multiplexed bit stream in this SCTE standard). Program Specific Information (PSI) identifies programs and the components of programs.

Not shown explicitly in Figure 4.1, but essential to the practical implementation of this Standard, is a control system that manages the transfer and processing of the elementary streams from the

application encoders. The rules followed by this control system are not a part of this Standard. The output of the control system implementation shall conform to the MPEG-2 Transport Stream coding as specified in ISO/IEC 13818-1 [8] with the additional constraints specified in this Standard.

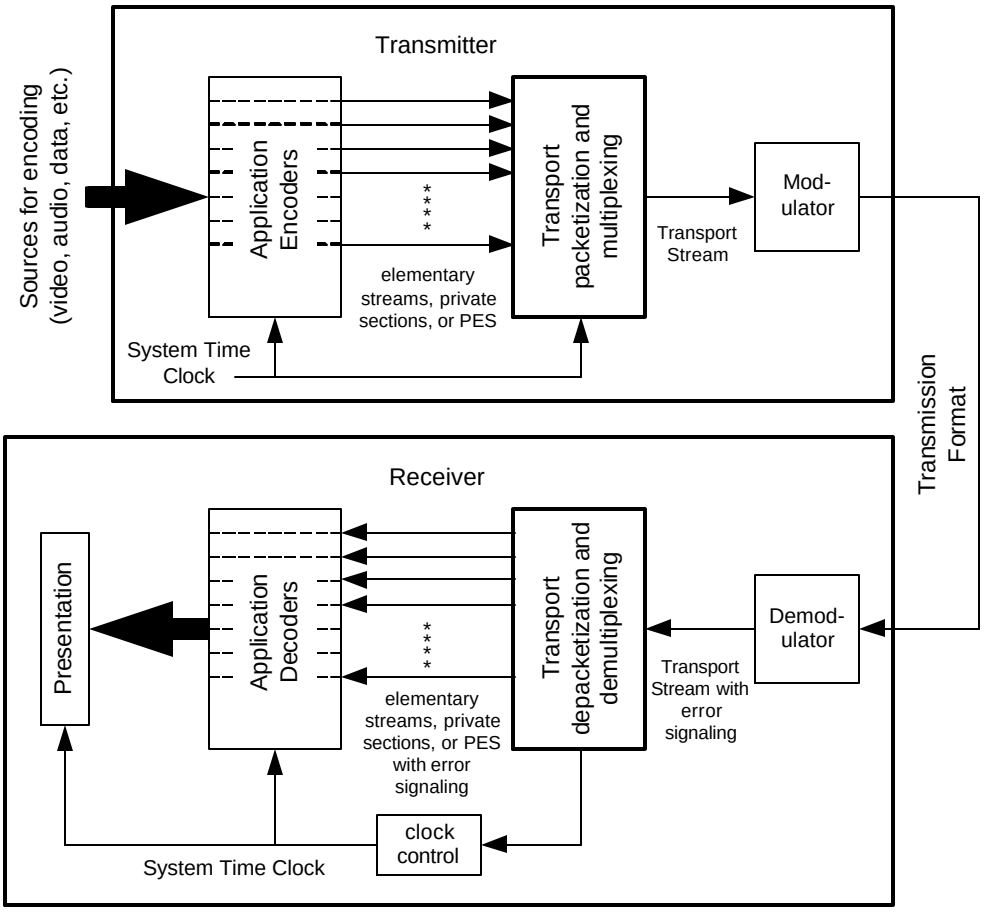

Figure 4.1 Sample organization of functionality in a transmitter-receiver pair for a single program.

5. SPECIFICATION

This Section constitutes the normative specification for the transport subsystem of the Service Multiplex and Transport Subsystem Standard for Cable Television. The syntax and semantics of the specification conform to ISO/IEC 13818-1, subject to the constraints and conditions specified in this Standard. This Section of the Standard describes the coding constraints that apply to the use of the MPEG-2 systems specification in the digital television system.

5.1 MPEG-2 Systems standard

The Transport Stream shall comply with all normative elements of ISO/IEC 13818-1 [8]. Certain constraints against the MPEG-2 Systems standard apply as defined in this document.

5.1.1 Video T-STD

The video Transport Stream System Target Decoder (T-STD) shall be based on Section 2.4.2.3 of ISO/IEC 13818-1 and follows the constraints for the level encoded in the video elementary stream.

5.1.2 Audio T-STD

The audio T-STD shall be defined as specified in Section 3.6 of Annex A of ATSC Standard A/52, and as further constrained in Annex B of ATSC Standard A/53.

5.2 Identification of MPEG-2 Private Ranges

ATSC coordinates code point assignments in the MPEG-2 user-private range and SCTE may define code points within this coordinated range.

5.2.1 MPEG-2 Registration Descriptor

Under circumstances as defined below, this Standard uses the MPEG-2 Registration Descriptor described in Section 2.6.8 and 2.6.9 of ISO/IEC 13818-1 [8] to identify the contents of programs and program elements to decoding equipment. No more than one MPEG-2 Registration Descriptor shall appear in any given descriptor loop.

5.2.2 Program Identifier

Programs which conform to ATSC or SCTE standards may be identified by the use of an MPEG-2 Registration Descriptor (as defined in Section 2.6.8 and 2.6.9 of ISO/IEC 13818-1 [8]). When present, the MPEG-2 Registration Descriptor shall be placed in the descriptor loop immediately following the program_info_length field of the TS_program_map_section() describing this program. The format_identifier field of this MPEG-2 Registration Descriptor shall have a value of 0x5343 5445 ("SCTE" in ASCII) or 0x4741 3934 ("GA94" in ASCII).

5.2.3 Audio Elementary Stream Identifier

Audio elementary streams which conform to ATSC standards may use an MPEG-2 Registration Descriptor (as defined in Section 2.6.8 and 2.6.9 of ISO/IEC 13818-1 [8]). When present, the MPEG-2 Registration Descriptor shall be placed in the descriptor loop immediately following the ES_info_length field in the TS_program_map_section() for each program element of stream_type 0x81 (AC-3 audio). The format_identifier field of the MPEG-2 Registration Descriptor shall have a value of 0x4143 2D33 ("AC-3" in ASCII).

5.2.4 Other Program Element Identifiers

Any program element carrying content not described by an approved ATSC or SCTE standard shall be identified with an MPEG-2 Registration Descriptor (as defined in Section 2.6.8 and 2.6.9 of ISO/IEC 13818-1 [8]). The format_identifier field of the MPEG-2 Registration Descriptor shall be

registered with the SMPTE Registration Authority, LLC[2]. The descriptor shall be placed in the descriptor loop immediately following the ES_info_length field in the TS_program_map_section() for each such non-standard program element.

The presence of an MPEG-2 Registration Descriptor in any descriptor loop shall not affect the meaning of any other descriptor(s) in the same descriptor loop. The ATSC Private Information Descriptor (defined in section 5.8.3.8) shall be the standard method to carry descriptor-based information associated with a private entity.

An MPEG-2 Registration Descriptor shall be placed in the descriptor loop immediately following the ES_info_length field in the TS_program_map_section() for each program element having a stream_type value in the user private range, 0xC4 to 0xFF, to establish the private entity associated with that program element.

An MPEG-2 Registration Descriptor present in the program information descriptor loop in the TS_program_map_section() (the descriptor loop immediately following the program_info_length field) shall apply to all program elements described in the TS_program_map_section(). An MPEG-2 Registration Descriptor may be present in the program information descriptor loop of the TS_program_map_section() only if it is applicable to all program elements described in that TS_program_map_section().

5.3 Audio Constraints

If a program contains one or more audio components, at least one shall be a complete main audio service (CM) as defined by ATSC Standard A/52A, including all voice-overs and emergency messages, when these are present in the Transport Stream.

5.4 Video Constraints

MPEG-2 programs shall be constrained to carry at most one MPEG-2 video Elementary Stream component.

5.5 Constraints on PSI

The program constituents for all programs are described in the PSI according to ISO/IEC 13818-1 [8]. The following constraints shall apply to the PSI information:

- Transport Stream packets identified by a particular PMT_PID value shall be constrained to carry only one program definition, as described by a single TS_program_map_section().
- The Transport Stream shall be constructed such that the time interval between the byte containing the last bit of the TS_program_map_section() containing television program information and successive occurrences of the same TS_program_map_section() shall be less than or equal to 400 milliseconds.
- The program_number values shall be associated with the corresponding PMT_PIDs in the Program Association Table (PAT). The Transport Stream shall be constructed such that the time interval

[2] The ISO/IEC-designated registration authority for the format_identifier is SMPTE Registration Authority, LLC. See (http://www.smpte-ra.org/html).

between the byte containing the last bit of the program_association_section() and successive occurrences of the program_association_section() shall be less than or equal to 100 milliseconds. However, when program_association_section()s, CA_section()s, and TS_program_map_section()s are approaching their maximum allowed sizes, the potential exists to exceed the 80,000 bps rate specified in ISO/IEC 13818-1 Sec. 2.4.2.3. In cases where the table section sizes are such that the 100 millisecond repetition rate of the program_association_section() would cause the 80,000 bps maximum rate to be exceeded, the time interval between the byte containing the last bit of the program_association_section() may be increased but in no event shall exceed 140 milliseconds, so that under no circumstances the limit of 80,000 bps is exceeded.

- Adaptation headers shall not occur in TS packets identified by a program_map_PID value for purposes other than for signaling with the discontinuity_indictor that the version_number (Section 2.4.4.5 of ISO/IEC 13818-1 [8]) may be discontinuous.
- Adaptation headers shall not occur in TS packets identified by PID 0x0000 (the PAT PID) for purposes other than for signaling with the discontinuity_indicator that the version_number (Section 2.4.4.5 of ISO/IEC 13818-1 [8]) may be discontinuous.
- Private table sections in addition to Program Map Tables may be present in TS packets PMT_PID identified by a program_map_PID value.

5.6 PES constraints

Packetized Elementary Stream syntax and semantics shall be used to encapsulate the audio and video elementary stream information according to ISO/IEC 13818-1. The Packetized Elementary Stream syntax is used to convey the Presentation Time-Stamp (PTS) and Decoding Time-Stamp (DTS) information required for decoding audio and video information with synchronism. This Section describes the coding constraints for this system layer.

Within the PES packet header, the following restrictions shall apply:

- PES_scrambling_control shall be coded as '00'.
- ESCR_flag shall be coded as '0'.
- ES_rate_flag shall be coded as '0'.
- PES_CRC_flag shall be coded as '0'.

Within the PES packet extension, the following restrictions shall apply.

- PES_private_data_flag shall be coded as '0'.
- pack_header_field_flag shall be coded as '0'.
- program_packet_sequence_counter_flag shall be coded as '0'.
- P-STD_buffer_flag shall be coded as '0'.

5.6.1 Audio PES constraints

The audio decoder may be capable of simultaneously decoding more than one elementary stream containing different program elements, and then combining the program elements into a complete program. In this case, the audio decoder may sequentially decode audio frames (or audio blocks) from each elementary stream and do the combining (mixing together) on a frame (or block) basis. In order to

have the audio from the two elementary streams reproduced in exact sample synchronism, it shall be required for the original audio elementary stream encoders to have encoded the two audio program elements frame synchronously; i.e., if audio program 1 has sample 0 of frame n at time t_0, then audio program 2 should also have frame n beginning with its sample 0 at the identical time t_0. If the encoding is done frame synchronously, then matching audio frames should have identical values of PTS.

If PES packets from two audio services that are to be decoded simultaneously contain identical values of PTS then the corresponding encoded audio frames contained in the PES packets should be presented to the audio decoder for simultaneous synchronous decoding. If the PTS values do not match (indicating that the audio encoding was not frame synchronous) then the audio frames which are closest in time may be presented to the audio decoder for simultaneous decoding. In this case the two services may be reproduced out-of-sync by as much as 1/2 of a frame time (which is often satisfactory, e.g., a voice-over does not require precise timing).

The value of stream_id for AC-3 audio shall be 1011 1101 (private_stream_1).

5.7 Services and features

5.7.1 System information and program guide

Transport Streams containing one or more unscrambled programs that include navigation data shall include service information defined in 5.7.1.1 below, describing the unscrambled programs. Timing aspects of the delivery of service information tables are defined in Sec. 5.7.1.2. The policy question of who is responsible for creating this service information (and its accuracy, completeness, formatting, and compliance with A/65A) is outside the scope of this standard.

Informative note: In the absence of a functioning POD module, receivers are expected to support navigation only to unscrambled services that are referenced in an in-band Virtual Channel Table present in the Transport Stream that carries the program.

When present, system information shall be formatted according to the structure and syntax described in ATSC A/65A [4]. System information data, when present, shall be transported in TS packets of PID 0x1FFB (the base_PID per [4]). PID 0x1FFB shall be reserved exclusively for this purpose.

At the option of the cable operator, data supporting construction of an Electronic Program Guide in the receiver in conformance with [4] may also be present.

Informative note: The following sub-sections describe the structure and syntax for system information, when present.

5.7.1.1 Service information tables

When present, the service information shall include the following tables at a minimum: the Master Guide Table (MGT), System Time Table (STT), and the Cable Virtual Channel Table (CVCT) or the Terrestrial Virtual Channel Table (TVCT). If any Program Map Table or Event Information Table on the Transport Stream includes a content_advisory_descriptor() quoting a rating_region *other than*

region 0x01 (U.S. plus possessions), the Rating Region Table (RRT) describing that region shall be transmitted. Delivery of the RRT corresponding to region 0x01 (U.S. and possessions) is optional because this table is standardized in EIA/CEA-766-A [7].

Those transmitted tables shall describe the unscrambled digital services multiplexed in the Transport Stream carrying those tables. The tables may optionally include information about analog channels, scrambled channels, as well as other digital channels available in different Transport Streams.

The 10-bit major_channel_number and minor_channel_number fields in the Cable Virtual Channel table represent either a two-part or a one-part virtual channel number associated with the virtual channel being defined. The one- or two-part number acts as the user's reference number for the virtual channel. Some channels in the CVCT may be represented with a one-part number while others are represented with two-part numbers.

To specify a two-part channel number both the major_channel_number and the minor_channel_number fields shall be below 1000. To specify a one-part channel number, the six most significant bits of major_channel_number shall be '11 1111'. Values and combinations of major_channel_number and minor_channel_number falling outside these ranges are reserved.

The one-part channel number is a 14-bit quantity that shall be computed by the following formula, represented in C syntax:

```
one_part_number = (major_channel_number & 0x00F) << 10 + minor_channel_number
```

Any given cable programming service may be represented either by a two-part channel number in a CVCT or a TVCT, or by a one-part channel number in the CVCT.

5.7.1.2 System information and program guide T-STD model

Table 5.1 lists the maximum cycle time for the SI tables required for in-band cable.

Table 5.1 Maximum cycle time for the STT, MGT, CVCT and RRT

Table	STT	MGT	CVCT	RRT (when present)
Cycle time (ms)	10000	150	400	60000

Table 5.2 lists the maximum transmission rate for SI streams according to their PIDs. The recommended maximum cycle time for EIT-0, if present, shall be 500 ms.

Table 5.2 Maximum rate for each PSIP packet stream

PID	base_PID	EIT_PID	ETT_PID
Rate (bps)	250,000	250,000	250,000

In cable applications, the SI streams identified by Transport Stream packets with PID 0x1FFB (base_PID) and EIT PIDs and ETT PIDs (if present) shall adhere to an T-STD model with the following parameters:

- sb_leak_rate shall be 625 (indicating a leak rate of 250,000 bps)
- sb_size shall be 1024 (indicating a smoothing buffer size of 1024 bytes)

5.7.2 Emergency alerts

Transport Streams may include Emergency Alert information. When present, Emergency Alert information shall conform to SCTE 18 2001, *Emergency Alert Message for Cable* [11]. When present, the cable_emergency_alert() table section shall be carried in TS packets with PID 0x1FFB (base_PID).

5.7.3 Specification of private data services

Private data may be transported by various means:

1. **Data services**—Carriage of data services including system information shall be as documented in applicable ATSC or SCTE Standards.
2. **Private program elements—**The stream_type codes in the range 0xC4 to 0xFF shall be available for stream types defined privately (not described by ATSC or SCTE Standards). Such privately-defined program elements shall include an MPEG-2 Registration Descriptor (see Sec. 5.2.4).
3. **Adaptation fields**— Private data may be transmitted within the adaptation field headers of TS packets (Sections 2.4.3.4 and 2.4.3.5 of ISO/IEC 13818-1 [8]). Program elements that include private data in the adaptation fields of their TS packets shall include an MPEG-2 Registration Descriptor (see Sec. 5.2.4).

5.7.4 MPEG-2 Still Pictures

Certain services may include video elementary streams conforming to the ISO/IEC 13818-1 Still Picture Model. Any elementary stream containing still picture data shall include a video_stream_descriptor() in accordance with ISO/IEC 13818-1 Sec. 2.6.2.

5.8 Assignment of identifiers

In this section, those identifiers and codes that shall have a fixed value are summarized. These include stream_type values and descriptor tags. Stream_type codes for program element types managed by the ATSC Code Points Registrar (currently assigned or available for future assignment) shall be in the range 0x80 to 0xC3. Descriptor_tag codes managed by the ATSC Code Points Registrar (currently assigned or available for future assignment) shall be in the range 0x40 to 0xEF.

5.8.1 Table IDs

Informative Table 5.3 lists table ID values applicable to this standard.

Table 5.3 Table ID Ranges and Values (Informative)

Table ID Value (hex)	Tables	PID	Reference
	ISO/IEC 13818-1 Sections:		
0x00	PROGRAM ASSOCIATION TABLE (PAT)	0	Ref. [8]
0x01	CONDITIONAL ACCESS TABLE (CAT)	1	Ref. [8]
0x02	TS PROGRAM MAP TABLE (PMT)	per PAT	Ref. [8]
0x03-0x3F	[ISO assigned or reserved]		
	User Private Sections:		
0x80-0xBF	[User Private]		
	A/65A Sections:		
0xC7	MASTER GUIDE TABLE (MGT)	0x1FFB	Ref. [4]
0xC8	TERRESTRIAL VIRTUAL CHANNEL TABLE (TVCT)	0x1FFB	Ref. [4]
0xC9	CABLE VIRTUAL CHANNEL TABLE (CVCT)	0x1FFB	Ref. [4]
0xCA	RATING REGION TABLE (RRT)	0x1FFB	Ref. [4]
0xCB	EVENT INFORMATION TABLE (EIT)	per MGT	Ref. [4]
0xCC	EXTENDED TEXT TABLE (ETT)	per MGT	Ref. [4]
0xCD	SYSTEM TIME TABLE (STT)	0x1FFB	Ref. [4]
	Data Broadcasting Tables:		
0xCE	DATA EVENT TABLE (DET)	per MGT	Ref. [5]
0xCF	DATA SERVICE TABLE (DST)	per PMT	Ref. [5]
0xD1	NETWORK RESOURCES TABLE (NRT)	per PMT	Ref. [5]
0xD2	LONG TERM SERVICE TABLE (LTST)	per PMT	Ref. [5]
	SCTE 18 2001:		
0xD8	CABLE EMERGENCY ALERT	0x1FFB	Ref. [11]
0xFF	ISO/IEC 13818-1 Forbidden		Ref. [8]

5.8.2 Stream Types

Stream type code values shall be as indicated in Table 5.4.

Table 5.4 Stream Type Codes

Value	Description
0x01	ISO/IEC 11172 Video
0x02	ITU-T Rec. H.262 | ISO/IEC 13818-2 Video
0x03	ISO/IEC 11172 Audio
0x04	ISO/IEC 13818-3 Audio
0x05	ITU-T Rec. H.222.0 | ISO/IEC 13818-1 private sections
0x06	ITU-T Rec. H.222.0 | ISO/IEC 13818-1 PES packets containing private data
0x07	ISO/IEC 13522 MHEG
0x08	ITU-T Rec. H.222.0 | ISO/IEC 13818-1 DSM-CC
0x09	ITU-T Rec. H.222.0 | ISO/IEC 13818-1/11172-1 auxiliary
0x0A	ISO/IEC 13818-6 type A (Multi-protocol Encapsulation)
0x0B	ISO/IEC 13818-6 type B (DSM-CC U-N Messages)
0x0C	ISO/IEC 13818-6 type C (DSM-CC Stream Descriptors)
0x0D	ISO/IEC 13818-6 type D (DSM-CC Sections – any type, including private data)
0x0E	ISO/IEC 13818-1 auxiliary
0x014	Non-streaming, synchronized data stream (Ref. [5])
0x80	Identical to ITU-T Rec. H.262 | ISO/IEC 13818-2 Video
0x81	ATSC A/53B audio (Ref. [3])
0x82	Standard subtitle (Ref. [13])
0x83	Isochronous data (Ref. [12])
0x95	Data Service Table, Network Resources Table (Ref. [5])
0xC2	Streaming, synchronized data stream (Ref. [5])
0xC3	Asynchronous data (Ref. [14])
0xC4-0xFF	User Private

5.8.2.1 Video Stream Type

The stream_type codes 0x02 or 0x80 shall be used for compressed MPEG-2 video elementary streams carried in transport packets defined by this standard. No other stream_type codes shall be used for this purpose.

5.8.2.2 Audio Stream Type

The stream_type code 0x81 shall be used for compressed ATSC A/53B [3] audio elementary streams carried in transport packets defined by this standard. No other stream_type codes shall be used for this purpose.

5.8.3 Descriptors

Descriptor tag values shall be as indicated in Table 5.5.

Table 5.5 Descriptors

Tag	Descriptor Name	Where Used	Reference
0x00-0x01	**ISO reserved**		
0x02	video_stream_descriptor()	PMT	Ref. [8]
0x03x04	**ISO defined**		Ref. [8]
0x05	registration_descriptor()	PMT	Ref. [8]
0x06-0x08	**ISO defined**		Ref. [8]
0x09	CA_descriptor()	PMT, CAT	Ref. [8]
0x0A	ISO_639_language_descriptor()	PMT	Ref. [8]
0x0B-0x0F	**ISO defined**		Ref. [8]
0x10	smoothing_buffer_descriptor()	PMT	Ref. [8]
0x11-0x13	**ISO defined**		Ref. [8]
0x14	association_tag_descriptor()	PMT	Ref. [5]
0x15-0x3F	**ISO reserved**		
0x80	stuffing_descriptor()	Anywhere	Ref. [2]
0x81	AC3_audio_descriptor()	PMT	Ref. [2]
0x86	caption_service_descriptor()	PMT, EIT	Ref. [4]
0x87	content_advisory_descriptor()	PMT, EIT	Ref. [4]
0xA0	extended_channel_name_descriptor()	VCT	Ref. [4]
0xA1	service_location_descriptor()	VCT	Ref. [4]
0xA2	time_shifted_service_descriptor()	VCT	Ref. [4]
0xA3	component_name_descriptor()	PMT	Ref. [4]
0xA4	data_broadcast_descriptor()	DET, EIT	Ref. [4]
0xA5	PID_count_descriptor()	DET, EIT	Ref. [4]
0xA6	download_descriptor()	DST	Ref. [4]
0xA7	multiprotocol_encapsulation_descriptor()	DST	Ref. [4]
0xA8	dcc_departing_request_descriptor()	DCCT	Ref. [4] Amd. 1
0xA9	dcc_arriving_request_descriptor()	DCCT	Ref. [4] Amd. 1
0xAA	rc_descriptor()	PMT, EIT	Ref. [4] Amd. 3
0xAC	MAC_Address_List_descriptor()	PMT	Ref. [15]
0xAD	ATSC_private_information_descriptor()	Misc.	Sec. 5.8.3.8
0xF0-0xFF	**User Private**		

5.8.3.1 AC-3 audio descriptor

When an Elementary Stream of stream_type 0x81 (AC-3 audio) is present in the digital television transport stream, an AC-3 Audio Descriptor (audio_stream_descriptor()) shall be included in the descriptor loop immediately following the ES_info_length field in the TS_program_map_section() describing that Elementary Stream. The syntax shall be as given in Table A2 of Annex A of ATSC Standard A/52A [2]. The following constraints shall apply to the AC-3 Audio Descriptor:

1. The value of the descriptor_tag shall be 0x81.
2. The num_channels field shall have a value in the range 1 to 13.
3. The langcod field is a reserved field. Audio language shall be indicated using an ISO 639 Language Descriptor (see Sec. 5.8.3.2 below).

4. The descriptor shall identify the type of the audio service in the bsmod field, which shall be the same as the bsmod field in the elementary stream associated with this descriptor.
5. The descriptor may terminate at one of two places:
   a. if describing a main audio service for which no associated services are available, immediately following full_svc; otherwise
   b. immediately prior to textlen.

Informative note: receiving devices are expected to use the bsmod (bit stream mode) field in the AC_3_audio_descriptor() to determine the type of each audio stream.

5.8.3.2 ISO 639 language descriptor

The ISO 639 Language Descriptor defined in ISO/IEC 13818-1 [8] Section 2.6.18 is used to indicate the language of audio Elementary Stream components. The ISO 639 Language Descriptor shall be included in the descriptor loop immediately following the ES_info_length field in the TS_program_map_section() for each Elementary Stream of stream_type 0x81 (AC-3 audio) when the number of audio Elementary Streams in the TS_program_map_section() having the same value of bit stream mode (bsmod in the AC-3 Audio Descriptor) is two or more.

Informative note: As an example, consider an MPEG-2 program that includes two audio ES components: a Complete Main (CM) audio track (bsmod = 0) and a Visually Impaired (VI) audio track (bsmod = 2). Inclusion of the ISO 639 Language Descriptor is optional for this program. If a second CM track were to be added, however, it would then be necessary to include ISO 639 Language Descriptors in the TS_program_map_section().

The audio_type field in any ISO 639 Language Descriptor used in this Standard shall be set to 0x00 (meaning "undefined").

An ISO 639 Language Descriptor may be present in the TS_program_map_section() in other positions as well, for example to indicate the language or languages of a textual data service program element.

5.8.3.3 Program smoothing buffer descriptor.

The Program Map Table of each program may contain a smoothing buffer descriptor pertaining to that program in accordance with Section 2.6.30 of ISO/IEC 13818-1. During the continuous existence of a program, the value of the elements of the smoothing buffer descriptor, if present, shall not change.

If present the fields of the smoothing buffer descriptor shall meet the following constraints:

- The field sb_leak_rate shall be allowed to range up to the maximum transport rates specified in Section 7.
- The field sb_size shall have a value less than or equal to 2048. The size of the smoothing buffer is thus 2048 bytes.

5.8.3.4 Video stream descriptor

Any elementary stream containing still picture data shall include a video_stream_descriptor() in accordance with ISO/IEC 13818-1 Sec. 2.6.2 in the TS_program_map_section() describing that elementary stream.

5.8.3.5 Component name descriptor

Whenever a service includes two or more audio components labelled with the same ISO_639_language_code (in the ISO 639 Language Descriptor) and bsmod (in the AC-3 Audio Descriptor), a unique component_name_descriptor() (as defined in Sec. 6.7.8 of ATSC A/65A [4]) shall be placed into the descriptor loop immediately following the ES_info_length field in the TS_program_map_section() to describe each such audio component.

Whenever a service includes an audio component whose bit stream mode (bsmod, as indicated in the AC-3 Audio Descriptor) is music and effects (ME) (bsmod = 1), and the component is a full service suitable for presentation (as indicated by the full_svc flag in the AC-3 Audio Descriptor being set) a unique component_name_descriptor() should be placed into the Elementary Stream information (inner) loop of the TS_program_map_section() to describe that component.

5.8.3.6 Caption service descriptor

When caption services are delivered within the picture user_data() construct defined in ATSC A/53B [3] Annex A, the caption_service_descriptor(), as defined in Sec. 6.7.3 of ATSC A/65A [4], shall be present in:

- the TS_program_map_section() (as defined in ISO/IEC 13818-1 sections 2.4.4.8 and 2.4.4.9 [8]) in the ES_info descriptor loop for the video program element; and
- the EIT-0 for that program, when EIT-0 is present in the Transport Stream.

5.8.3.7 Content advisory descriptor

For current programs, the content_advisory_descriptor(), as defined in ATSC A/65-A [4] section 6.7.4, when present, shall be carried in the TS_program_map_section() (as defined in ISO/IEC 13818-1 sections 2.4.4.8 and 2.4.4.9 [8]) in the descriptor loop immediately following the program_info_length field. When content advisories are present for a current program and EIT-0 is present in the Transport Stream, the content_advisory_descriptor() shall be present in EIT-0 for that program. Content advisories for future programs may be carried in the appropriate EIT, if EIT data is present in the Transport Stream. The only rating regions currently defined for cable use are Region One, the US plus possessions (value 0x01 for the rating_region field) and Region Two, Canada (value 0x02 for the rating_region field).

5.8.3.8 ATSC private information descriptor

The ATSC_private_information_descriptor() provides a method to carry and unambiguously label private information. More than one ATSC_private_information_descriptor() may appear within a single descriptor loop. Table 5.6 defines the bit-stream syntax of the ATSC_private_information_descriptor().

Table 5.6 – ATSC Private Information Descriptor

Syntax	Bits	Format
ATSC_private_information_descriptor() {		
descriptor_tag	8	0xAD
descriptor_length	8	uimsbf
format_identifier	32	uimsbf
for (i = 0; i < N; i++){		
private_data_byte	8	bslbf
}		
}		

descriptor_tag – This 8-bit field is set to 0xAD.

descriptor_length – This 8-bit field specifies the number of bytes of the descriptor immediately following the descriptor_length field.

format_identifier – The format_identifier is a 32-bit field as defined in ISO/IEC 13818-1 [8], section 2.6.8 and 2.6.9 for the registration_descriptor(). Only format_identifier values registered and recognized by the SMPTE Registration Authority, LLC shall be used (see http://www.smpte-ra.org/mpegreg.html). Its use in this descriptor shall scope and identify only the private information contained within this descriptor.

private_data_byte – The syntax and semantics of this field is defined by the assignee of the format_identifier value.

5.8.3.9 Other A/65A descriptors

Inclusion in the Transport Stream of descriptors defined in ATSC A/65A [4] shall conform to the requirements specified in [4] for table sections carried on cable.

5.8.4 PID Assignments

The following table defines PID assignments. Values not indicated in the table are managed within the ATSC Code Point Registry.

Table 5.7 PID Assignment

PID Range	Description
0x0000	ISO/IEC 13818-1 Program Association Table
0x0001	ISO/IEC 13818-1 Conditional Access Table
0x0002	ISO/IEC 13818-1 Transport Stream Description Table
0x0003-0x000F	ISO/IEC 13818-1 Reserved
0x0050-0x1FEF	May be used for elementary streams, private data, or Program Map Table data
0x1FFB	PSIP and EA data (Ref. [4] and [5])
0x1FFE	Reserved for DOCSIS
0x1FFF	ISO/IEC 13818-1 Null packet

In order to avoid fixed PID values and ranges already established in this and other international standards, and to accommodate future extensions, PID values used to identify Transport Stream packets carrying TS_program_map_section() and Elementary Stream program elements shall be in the range 0x0050 through 0x1FEF, inclusive.

5.9 Extensions to the MPEG-2 Systems specification

This Section covers extensions to the MPEG-2 Systems specification.

5.9.1 Scrambling control

The scrambling control field within the TS packet header allows all states to exist in the digital television system as defined in Table 5.8.

Table 5.8 Transport Scrambling Control Field

transport_ scrambling_ control	Function
00	packet payload not scrambled
01	not scrambled, state may be used as a flag for private use defined by the service provider.
10	packet payload scrambled with “even” key
11	packet payload scrambled with “odd” key

Elementary Streams for which the transport_scrambling_control field does not exclusively have the value of ‘00’ for the duration of the program, shall carry a CA_descriptor in accordance with Section 2.6.16 of ISO/IEC 13818-1.

5.10 Service Acquisition Considerations (Informative)

The ISO/IEC 13818-1 (MPEG-2 Systems) [8] and 13818-2 (MPEG-2 Video) standards specify minimum rates for inclusion of PTS indicators in the bit stream (at least every 700 milliseconds). These standards also require inclusion of a video sequence_header just once per sequence, where a sequence could be several hours long. Service providers may (and often will) choose rates for delivery of data critical to fast acquisition of the service that exceed the minimum rates mandated by MPEG.

Care in creation of the multiplex can optimize service acquisition time within the same multiplex, acquisition time to a new multiplex, acquisition of scrambled services, changes between film and video modes (both directions), and change from video to still pictures mode. Service providers may choose to send PTS values more often, such as once per picture. They may repeat sequence_header information frequently, for example once every 0.5 seconds, and for scrambled services, repeat relevant ECMs at a similar rate. These provisions can result in improved acquisition performance at the expense incurring a small increase in bandwidth usage.

6. FEATURES OF ISO/IEC 13818-1 NOT SUPPORTED BY THIS STANDARD

The transport definition is based on the MPEG-2 Systems standard, ISO/IEC 13818-1; however, it does not implement all parts of the standard. This Section describes those elements which are omitted from this Standard.

6.1 Program streams

This Standard does not include those portions of ISO/IEC 13818-1 [8] and Annex A of ATSC Standard A/52A [2] which pertain exclusively to Program Stream specifications.

7. TRANSPORT ENCODER OUTPUT BIT RATES

Conceptually, the output from the transport subsystem is a continuous MPEG-2 Transport Stream as defined in this Standard at a constant rate of T_{64} Mbps when transmitted in an 64 QAM system and T_{256} when transmitted in a 256 QAM system where:

T_{64} = 26.97035 Mbps

and

T_{256} = 38.81070 Mbps.

The symbol rates in Msymbols per second for the transmission subsystem (see Table 3 of Ref. [1]) are:

S_{64} = 5.056941 Msps

and

S_{256} = 5.360537 Msps.

T_{64} and S_{64} are locked to each other in frequency. Also T_{256} and S_{256} are locked to each other in frequency.

All Transport Streams conforming to this Standard shall conform to the ISO/IEC 13818-1 model.